Chemistry
Ticket Out the Door
Set 11: Relationship between wavelength, frequency, energy, and light

Name _____ Period _____

Skill 11.01 Exercise 1

Refer to the figure shown to the right. Identify the range of wavelengths associated with each color. The "Reds" have already been filled in.

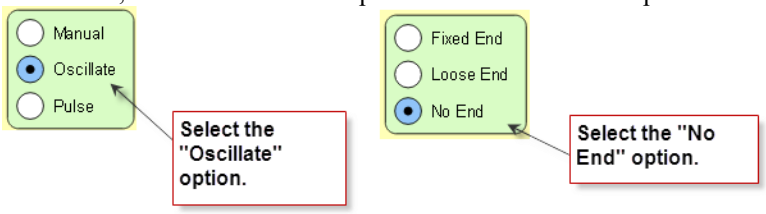
Color Range	Wavelengths
Reds	680–740
Oranges	
Yellows	
Greens	
Blues	
Violets	

Skill 11.01 Exercise 2

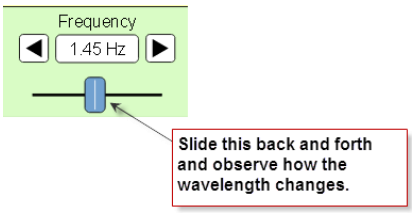
Navigate to the wave on a string simulator.

http://phet.colorado.edu/sims/html/wave-on-a-string/latest/wave-on-a-string_en.html

Once there, select the "No end" option and the "Oscillate" option



(a) Locate the frequency slider. Move it back and forth and observe how the wavelength changes.



(i) When you increase the frequency, what happens to the wavelength? Does it increase or decrease?

(ii) When you decrease the frequency, what happens to the wavelength? Does it increase or decrease?

(iii) What is the relationship between frequency and wavelength? Is it inverse or direct?

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Skill 11.01 Exercise 3

Refer to the colors below. Sort the colors from low to high with respect to frequency.

Color Range	**Order of frequency (1 = lowest)**
Reds	
Oranges	
Yellows	
Greens	
Blues	
Violets	

Skill 11.02 Exercise 1

For each of the colors below,

(a) Indicate the average wavelength in nanometers (nm)
(b) Convert each wavelength to nanometers (1×10^{-9} m = 1 nm)
(c) Calculate the frequency

Color Range	**Average λ (nm)**	**λ (m)**	**ν (/s)**
Reds	710 nm	$710\text{nm} \times \frac{1\text{m}}{1x10^{9}\text{ nm}} = 7.10 \times 10^{-7}\text{ m}$	$\frac{3.00 \times 10^{8}\text{ m/s}}{7.10 \times 10^{-7}\text{ m}} = 4.23 \times 10^{14}\text{ /s}$
Oranges			
Yellows			
Greens			
Blues			
Violets			

(a) Are the wavelengths of ultra-violet light longer or shorter than that of visible light?

(b) Are the frequencies of ultra-violet light longer or shorter than that of visible light?

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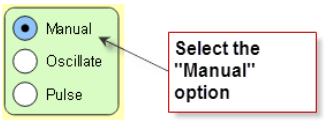
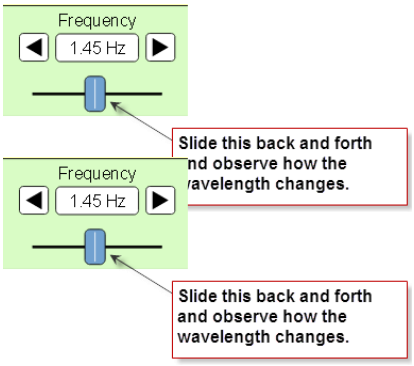
(c) Are the wavelengths of infra-red light longer or shorter than that of visible light?
(d) Are the frequencies of infra-red light longer or shorter than that of visible light?

Skill 11.03 Exercise 1

Now return to the simulator (http://phet.colorado.edu/sims/html/wave-on-a-string/latest/wave-on-a-string_en.html) Select the "Manual" option.



Move the wrench up and down as fast as you can and observe the wavelength. Now move the wrench up and down slowly and observe the wavelength.



(i) When you moved the wrench up and down quickly (high energy), what happened to the wavelength? Did it increase or decrease?

(ii)When you moved the wrench up and down slowly (low energy), what happened to the wavelength? Did it increase or decrease?

(i) What is the relationship between energy and wavelength? Is it inverse or direct?

Skill 11.03 Exercise 2

Refer to the colors below. Sort the colors from low to high with respect to energy.

Color Range	**Order of energy (1 = lowest)**
Reds	
Oranges	
Yellows	
Greens	
Blues	
Violets	

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Skill 11.04 Exercise 1

Refer to problem 8.02 Problem 1

(d) For each color, copy the corresponding frequency

(e) Calculate the energy in joules

Color Range	**frequency** ν	**Energy (J)**
Reds	4.23×10^{14} /s	$(6.63\times10^{-34}\ \text{J}\bullet\text{s})(4.23\times10^{14}\ \text{/s})$ $= 2.80\times10^{-19}\ \text{J}$
Oranges		
Yellows		
Greens		
Blues		
Violets		

(a) How do the energies of ultra-violet compare to visible light?

(b) How do the energies of infra-red light compare to visible light?